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(54) Abstract Title

Mobile radio system

(57) A mobile radio system is disclosed which supports group calls to a predetermined group of mobile radio units. If sufficient radio and system resources are not available to connect the call to all the target mobile radio units which can be located, the call is connected to those for which a suitable communication path is available whilst the contents of the call is stored for subsequent transmission to those target mobile radio units for which no suitable communication path was available.

A mobile radio unit comprising means for storing the contents of a call is also disclosed.

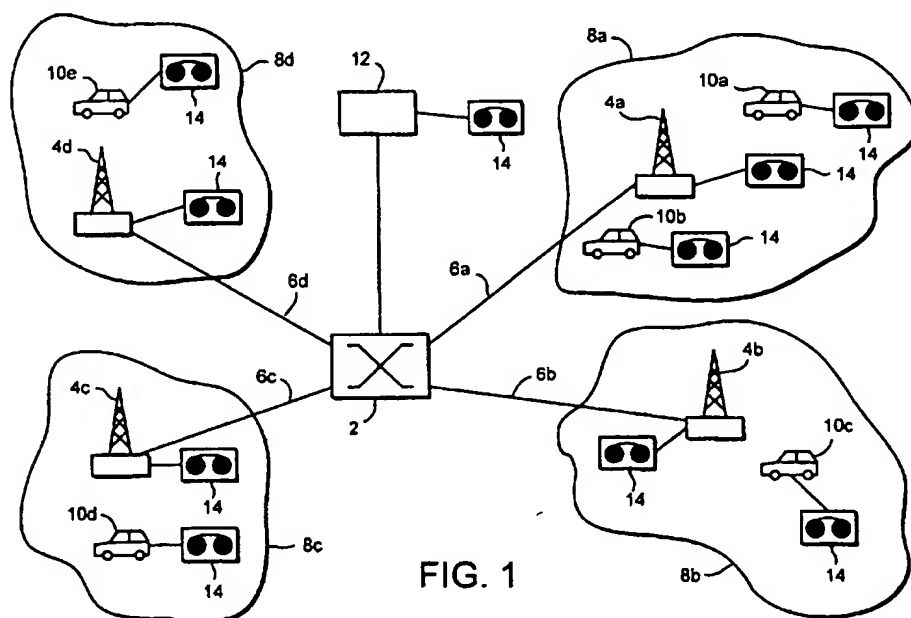


FIG. 1

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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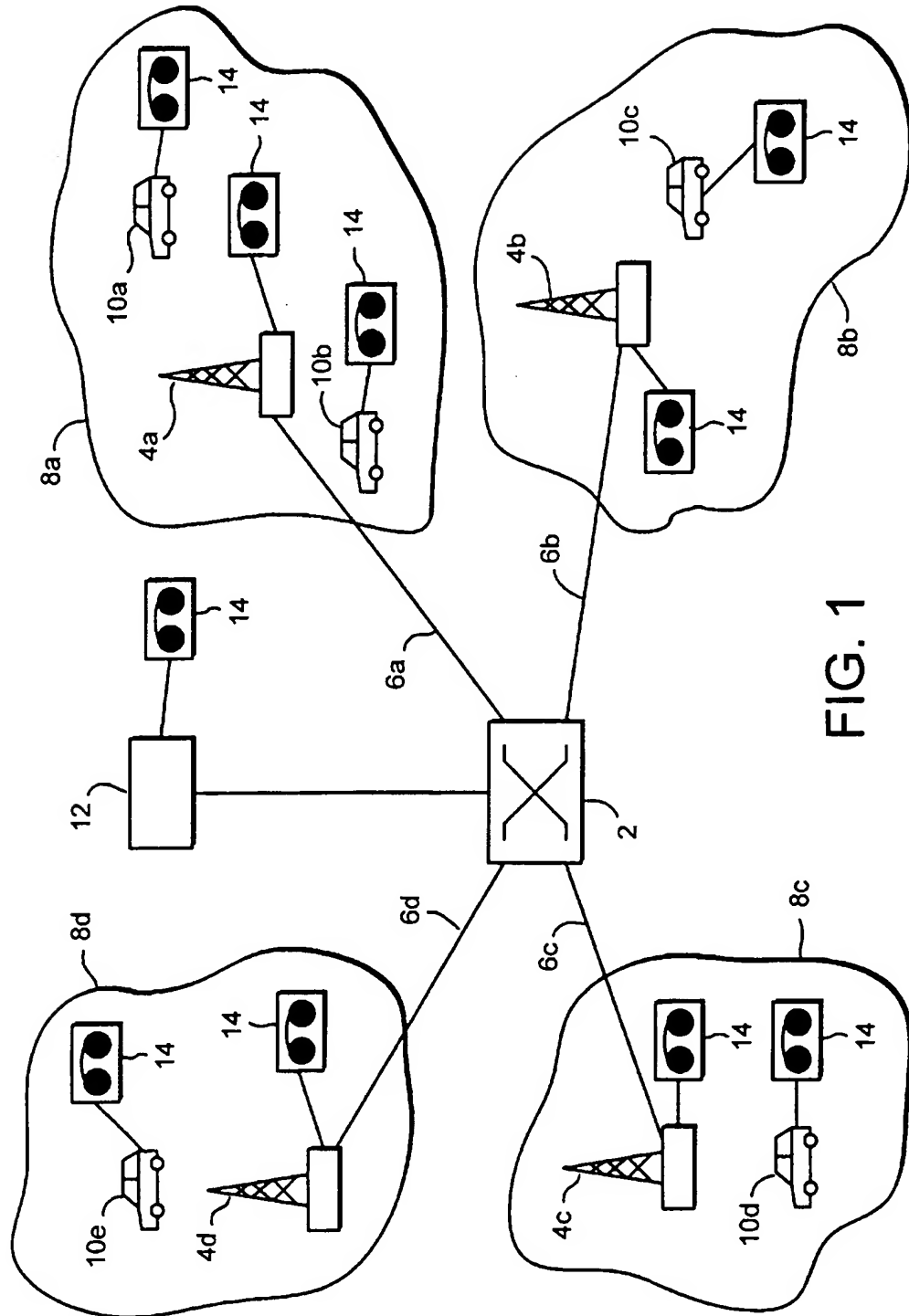


FIG. 1

Mobile Radio System

5 This invention relates to the queuing of messages
in a mobile radio communication system and relates
particularly, but not exclusively, to mobile radio
systems, such as TERrestrial Trunked Radio (TETRA)
systems, which permit call queuing and calls to groups
of several users at a time.

10 Mobile radio systems generally comprise a basic
structure of a central switching centre connecting a
number of physically separated base stations whose
ranges define radio coverage cells. Many such systems,
particularly TETRA systems as mentioned above, operate
15 by providing the base station for each cell with a pool
of radio channels which are allocated when required for
a call. If there are no free channels at the base
station when a request to set up a call is received,
then the request is queued at the base station until a
20 channel becomes free. This may be reasonably acceptable
when the call is an ordinary one-to-one call, i.e. a
call between two individual mobile radios or a call
between a fixed location and a mobile radio.

However, if a calling party attempts to make a
25 group or a broadcast call to several called parties at
once, then it is usually necessary for the calling party
to wait until sufficient channels become free to call
all those mobile radios for whom the call is intended.
These mobile radios could be spread across more than one
30 coverage cell and thus it may be necessary for the
calling party to wait until a spare channel is available
in each of a number of cells. In peak traffic times,
this could lead to an unacceptably long delay.

There may be other reasons why one or more of the
35 members of the group is unavailable. For example they
may be engaged on another call or the mobile radio may
be switched off or out of range.

A long delay for a mobile radio user wishing to make a speech broadcast or group call is significantly less acceptable than where a user wishes to use text paging via a keyboard operator or a text message such as the Short Message Service (SMS) for example. This is because for the group call, the user is prevented even from placing the message rather than a delay simply occurring in its delivery. In the context of a text paging message as mentioned above, delays are inherent due to the message having to be typed by a keyboard operator or by the user on a keypad and hence such messages tend to be less urgent.

According to one aspect of the present invention there is provided a method of operating a mobile radio system comprising attempting a call to at least one target mobile radio unit, determining whether a communication path is available from the point of origin of said call to the or each target mobile radio unit that can be located, and if a suitable communication path is not available, then storing the contents of said call as a message for later transmission to said target mobile radio unit.

The invention also extends to a mobile radio system and thus when viewed from a second aspect the invention provides a mobile radio system comprising a plurality of mobile radio units, means for attempting a call to at least one of said mobile radio units, means for determining whether a suitable communication path is available between said means for attempting a call and the or each mobile radio unit to which the call is to be sent that can be located, and means to store the contents of said call as a message for later transmission to those mobile radio units for which it is determined that no suitable communication path is available.

Thus it will be seen that in the present invention, when a call to one or more mobile radio units is

attempted, it is checked if there is a suitable communication path from the caller to the target called mobile radio unit or units that can be located, i.e if radio and system resources such as radio channels to
5 connect the caller to the target mobile radio unit or units are available. If a suitable communication path is not available, the contents of the call are stored for future transmission as a message to those located mobile radio units to which it is not possible to
10 connect immediately.

A suitable communication path will be unavailable if there are insufficient system resources for the call to be connected. This could be as a result of no traffic channels being available at the base station
15 serving the call originator and/or the same being true at a base station serving a target mobile radio unit or the target mobile radio unit being engaged on another call. If any of the target mobile radio units cannot be located - e.g. because they are switched off or out of
20 range, no determination of whether there is a suitable communication path is made since this is not relevant. Thus a communication path is available if there are sufficient resources to place the call with recipients which can be located.

25 Where a suitable communication path to a located target mobile radio unit is available the call most preferably proceeds as normal i.e. it is connected immediately to the available units. Thus where a group of plural mobile radio units is called, the call can be
30 connected to the available units and a message stored for the rest. Thus in accordance with the invention, a user may carry out a call to one or more mobile radio units straightaway without having to wait for radio or system resources sufficient to connect to all the
35 intended recipients to become available.

The present invention contrasts with storing a request to connect, as occurs when calls are queued in a

mobile radio system, or simply refusing to connect a call if the communication path to the or at least one of the target mobile radio units is not available. In a system operating in accordance with the invention, at least in its preferred embodiments, a group voice call to plural mobile radio units in several coverage cells will go ahead without having to wait for suitable radio channels to be available for each of the target mobile radio units and yet all the locatable units will eventually receive the call.

In accordance with the invention, the contents of a call are stored if a suitable communication path is not available to a located mobile radio unit. Preferably the contents of the call are also stored in the event that the target mobile radio unit cannot be located e.g. because it is out of range or switched off. Such an arrangement ensures that all intended recipients can receive the contents of the call eventually even if they could not be located when the call was placed.

If the contents of a call are to be stored in accordance with the invention, this may happen immediately and automatically so that the originator would probably be unaware that the call was being stored. In some circumstances however it might be preferable to give the originator a warning that the call is not being placed immediately with the or all intended recipients. Such a warning could be a mobile one such as a spoken announcement or beep, or it could be a visual one e.g. on a display screen.

The later transmission attempts are preferably made automatically and without requiring a request from the intended recipient for the stored call contents (message) to be transmitted. They may be made after a predetermined interval, or at successive predetermined intervals. Preferably, however, the message is automatically transmitted to the or each mobile radio unit for which a suitable communication path was not

available as soon as radio (and other) resources permit. This could be achieved by, for example, checking repeatedly whether a suitable communications path is available for the or each mobile radio unit for which a path was not available and transmitting the stored message to a mobile radio unit substantially immediately it is determined that a path is available. The system could, for example, be arranged such that suitable radio resource becoming available triggers automatic and immediate transmission of the stored message. In these arrangements, the stored message could be arranged to have priority over some or all other types of calls that may be queuing to allow its more immediate transmission, if desired.

Of course suitable resources may become available whilst the originator of the call is still storing the contents of the call. In this case the system could wait until storage has finished before forwarding the stored message using the newly available resources. Preferably however the forwarding of the part of the message already stored is effected when it would otherwise have been irrespective of whether or not a message is still being stored. Under these circumstances the message storage means acts as a temporary buffer. Such an arrangement is beneficial since it minimises the delay in the message getting to the target mobile radio unit or units and also means that the length of the message is not constrained by an absolute or predetermined artificial maximum capacity for the storage means.

More than one message for a given recipient may be stored in the storage means, in which case the messages are queued. They may be stored in purely chronological order, although in some embodiments a message originator may ensure that a message jumps any queue e.g. by giving it a higher priority tag.

In some preferred embodiments, the contents of the

call may be stored as a message at an intermediate point in the radio communications network. For example, where the call is intended for mobile radio units distributed between a number of coverage cells, then the call
5 message may be stored at the base stations for cells containing mobile radio units for which no communication path is available. According to a third aspect therefore, the invention provides a communications network comprising a plurality mobile radio units and a
10 plurality of base stations, each base station comprising means to store a message for subsequent retransmission to at least one mobile radio unit.

Additionally or alternatively, the contents of the call may be stored at its point of origin. This is
15 advantageous in allowing a user to place a call in circumstances where there is no available communication channel between the user and a base station, i.e. the first leg of the necessary communication path is unavailable. In circumstances where storage means are
20 provided both at the point of origin and elsewhere in the network, such as a cell base station and there is no communication path directly to the intended recipient or recipients, then the system preferably forwards a message to a second storage means when a suitable part
25 of a communication path becomes available to enable such forwarding. Thus, where a message is stored at the point of origin e.g. as a result of a lack of a communication channel to a base station, the message may be forwarded, preferably automatically, when a channel
30 becomes available. The message could be forwarded straight to the intended recipient or recipients, or it may need to be restored elsewhere in the network, for example, at one or more cell base stations.

Wherever a message is stored in accordance with the
35 invention, it may be deleted automatically once it has been forwarded, it may be deleted after a predetermined time period, or it may be automatically overwritten by a

subsequent message once the original has been forwarded. Preferably however messages may be optionally preserved until their deletion has been deliberately specified. Such an arrangement gives the possibility of

5 transmitting a message more than once to one or more of the original target mobile radio units. This could be useful for example where the message took the form of an alarm or alert of a standard type which could then be sent to the required users, e.g. all the members of a
10 group whenever necessary.

The stored message can then be sent again to all the members of a group at a later time upon an appropriate trigger - e.g. upon the initiation of the originator of the call. When the message is sent again
15 it is likely that a different set of mobile units will be determined to have no suitable communication path to them, in which case the message is stored for this new set of mobile units, whether or not, for example, the message is deleted for those mobile units for which a
20 path was available the second time.

In this latter arrangement the message to be repeatedly sent could be stored at a number of locations in the radio system or only at a single location. It is preferably stored only at the point of origin or by the
25 originator of the call, since the rest of the network may then simply treat the subsequent transmission of the message as a fresh call.

A call could be attempted by a fixed location e.g. a despatch centre. In the embodiments of the invention
30 incorporating this feature, the despatch centre could comprise storage means for storing the contents of the call as a message when a suitable communication path to the or each target mobile radio unit is not available. However, in preferred embodiments of the invention
35 storage means are not necessary where the point of generation is a fixed location since a terrestrial link to the switching centre may be used, making it less

likely that a communication path to the switching centre is not available. In such embodiments therefore, the storage means are advantageously located elsewhere in the network.

5 The point of origin of the call could equally be a mobile radio unit similar to the mobile radio unit or units for which the message is intended. Such a mobile radio unit could therefore comprise storage means for storing a message when a communication path to the intended recipient or recipients of the message is not available (i.e. there is a delay in granting of the call and the call is not granted substantially immediately). Such a mobile radio unit is believed to be novel and advantageous in its own right and therefore from a further aspect the invention provides a mobile radio unit comprising storage means for storing a message when a suitable communication path to another part of a communications network is not available, and means for transmitting said message to said communications network when such a communication channel becomes available.

20 A mobile radio unit in accordance with this aspect of the invention offers substantial benefits over known mobile radio units. For example, when a user wishes to transmit a message to one or more other mobile radio units, as opposed to wishing to conduct a two-way conversation, the user need not be concerned with whether or not sufficient system resources are available to place the call. The message will be stored at the user's mobile radio unit and forwarded later once this has become possible. The storage means thus preferably stores the message in such a way as to identify the intended recipient or recipients, thereby enabling the network to ensure that it is properly delivered.

30 As well as storing messages for later transmission when one or more suitable communication paths is unavailable, the storage means of the present invention may additionally act as a buffer to store part or all of

a message even when suitable communication paths are available and a call has been granted to one or more of the target mobile units, for example to alleviate any delay between acceptance of the call request by the network and actual transmission of speech (it should be noted that such delay is not considered to represent a suitable communication path being unavailable, rather the path is available, but there is a delay in transmitting the signal on it).

10 A mobile radio unit comprising means for storing a speech message may in fact also be useful to the user as a way of storing messages for himself such as spoken reminders. A mobile radio unit comprising means for storing sound, e.g. speech, and replaying it to a user and not just for storing a message for subsequent retransmission to another part of a communications network, is believed to be novel and advantageous in its own right, and therefore from a further aspect the invention provides a mobile radio unit comprising means for storing sound and means for subsequently replaying said stored sound.

20 In the present invention, the call attempted may be for transmission to just one mobile radio unit, but preferably the call is for transmission to more than one mobile radio unit, e.g. it is a group call to a predetermined group of mobile radio units. The advantages of the invention are realised more fully where a call to several other parties is being attempted since it is in these circumstances that unacceptably long queuing delays can be encountered. Furthermore a later transmitted message is likely to be a more acceptable compromise in the context of a group call than it would be if just one other user is being called when normally only a two-way call will suffice.

30 The call contents could be stored at one location without being transmitted to any target mobile radio units until such time as communication channels are

available to all of the intended recipient mobile radio units, but preferably the call is connected immediately for those mobile radio units to which immediate connection can be made and its contents stored for those mobile radio units for which a suitable communication channel is not available when the call is made. For example, the intended recipient mobile radio units may be distributed across a number of coverage cells, some of the base stations for which may have free channels, with others not having free channels. In this example, the message could be stored only at each base station which does not have a suitable communication channel to the intended recipient mobile radio unit or units located within its coverage cell.

A call or attempted call between one user and a plurality of mobile radio units may be in the form of a broadcast call, in which a message is broadcast to the mobile radio units so as to be received by the respective users, without any replies being expected. In some preferred embodiments however, the method of the present invention comprises the step of and the system of the present invention comprises means for, storing a reply to a message for subsequent retransmission to the point of generation of the message when a suitable communication path is not available. Thus by means of this feature, the call or attempted call to a plurality of mobile radio units may be in the form of a group call in which replies to the originator of the message are possible. By providing means for storing a reply, then the same advantages are achieved as for storing the original message.

Moreover, in further preferred embodiments, replies to the message are provided with means to identify the source of the reply. For example, the reply message could be prefixed by a spoken 'name file' which is a recording of a user's name, or it may simply be in the form of a number such as a telephone or ID number or it

could be in the form of text. Clearly, where a message is sent to a number of mobile radio units, each of which may send a reply, then the replies may only be dealt with one at a time. Providing means to identify the source of the reply in addition to means for storing said replies, allows the replies to be particularly conveniently handled so as to be queued for sequential listening by the user who generated the original message.

10 The calls and messages in accordance with the present invention may be of any desired type. For example they may comprise a sound such as voice or speech, which may be stored in analogue form, or more preferably in digital form.

15 Wherever in a mobile radio system the message is stored, the storage means may comprise any means suitable for the type or types of message which are to be stored. For example, the storage means may comprise a magnetic disk or magnetic tape. Preferably however, 20 the storage means comprises a solid-state memory for storing digital data representing the message.

 The storage means may store messages indefinitely until such time as they can be delivered. Preferably however, the storage means deletes or comprises means to 25 delete unsent messages after a predetermined interval. This avoids the storage means becoming clogged when there is prolonged network congestion.

 The mobile radio system in accordance with at least some aspects of the present invention may be a private 30 system - i.e. where calls can only be made amongst a closed group of users, e.g. a TETRA private mobile radio system. Equally however it may instead be a public system such as a cellular telephone network.

35 The means for carrying out methods in accordance with the present invention may comprise pure hardware means such as discrete components or hard-wired logic gates. Alternatively, the methods may be implemented at

least partially using software e.g. computer programs.
It will thus be seen that when viewed from a further
aspect the present invention provides computer software
specifically adapted to carry out the methods
5 hereinabove described when installed on data processing
means. The invention also extends to a carrier
comprising such software which when used to operate a
mobile radio system comprising a digital computer causes
in conjunction with said computer said system to carry
10 out the steps of the method of the present invention.
Such a carrier could be a physical storage medium such
as a ROM chip, CD ROM or disk, or could be a signal such
as an electronic signal over wires, an optical signal or
a radio signal such as to a satellite or the like.

15 It will further be appreciated that not all steps
of the method of the invention need be carried out by
computer software and thus from a further broad aspect
the present invention provides computer software and
such software installed on a carrier for carrying out at
20 least one of the steps of the methods set out
hereinabove. In particular the step of generating a
message does not need to involve the use of software.

A preferred embodiment of the present invention
will now be described, by way of example only, with
25 reference to the accompanying drawing which is a
schematic diagram of a mobile radio system in accordance
with the present invention.

Referring to Fig. 1, there is shown a TETRA mobile
radio system in which speech is sent digitally between
30 mobile radio units as encoded information which phase
shift keys a radio carrier. Digital signalling and
users' text and visual data are transmitted in a similar
fashion. The mobile radio system comprises a switching
centre 2 which includes a digital computer onto which is
35 loaded software for operating the switching centre. The
centre 2 is connected to four base stations 4a, 4b, 4c
and 4d by means of fixed terrestrial links 6a-6d. Each

base station generates a coverage cell 8a-Sd, the shape of which is defined by buildings etc. and geographical features such as hills. Within each coverage cell 8a-Sd are mobile radio units, e.g. 10a-10e.

5 Also connected to the switching centre 2 is a despatch centre from which an operator using a terminal 12 may call the mobile radio units 10a-10e.

10 The switching centre 2, the despatch terminal 12, the base stations 4a-4d and the mobile radio units 10a-10e all comprise means 14, in the form of solid state memory circuits, for storing digitally encoded speech messages for subsequent transmission to another part of the network.

15 An example of the operation of this system will now briefly be described. An operator at the despatcher terminal 12 decides to send a group call to the mobile units 10a-10e, to which replies are invited. Base stations 4b, 4c and 4d have a suitable radio channel available, but base station 4a does not. Thus
20 communication paths are available for mobile radio units 10c, 10d and 10e but the call contents are stored as a message in the storage means 14 at the base station 4a until a suitable radio channel becomes available to complete the communication path. The message may then
25 be transmitted to mobile radio units 10a and 10b.

30 However, when base station 4a has an available radio channel, mobile radio unit 10b may already be engaged on another call. The message is therefore retained to be stored at base station 4a until the mobile radio unit 10b completes its call.

35 Each of the mobile radio units 10a-10e may decide to send a reply. If, for example, base station 4c has no available radio channels when mobile radio unit 10d decides to send a reply, then the reply message may be stored at the storage means 14 in the mobile radio unit 10d. This reply message is subsequently transmitted to the base station 4c and onward to the despatcher

terminal 12 when suitable channels become available for each leg of the communication path. If the despatch terminal 12 is already engaged on another call, then the reply message is stored at the storage means 14 of the despatcher terminal 12 until the call is finished.

5 Instead of the despatcher terminal 12, mobile radio unit 10a may decide to make a group voice call to the other mobile radio units 10b-10e. If base station 4a has no available radio channels at the time, then the
10 contents of the call may be stored as a message at the storage means 14 in the mobile radio unit 10a, until such time as a radio channel becomes available.

Once a call has been transmitted to the base station 4a from the mobile radio unit 10a, it is sent
15 via the switching centre 2 to base stations 4b, 4c and 4d, from where it may either be stored in the respective storage means 14 if any of these base stations do not have a suitable radio channel available or the target mobile radio units are unavailable, or it may be
20 transmitted directly to the mobile radio units 10c, 10d and 10e. Once the call is received by base station 4a, then it is also retransmitted by base station 4a to the other mobile radio unit 10b in the same cell as the originating unit 10a.

25 Replies may be sent in an exactly analogous manner and are automatically prefixed by the respective mobile radio unit sending the reply with a speech message containing the name of the user of that mobile radio unit.

Claims:

1. A mobile radio system comprising a plurality of mobile radio units, means for attempting a call to at least one of said mobile radio units, means for determining whether a suitable communication path is available between said means for attempting a call and the or each target mobile radio unit to which the call is to be sent that can be located, and means to store the contents of said call for later transmission to those target mobile radio units for which it is determined that no suitable communication path is available.
2. A mobile radio system as claimed in claim 1 wherein said means for attempting a call is arranged to attempt said call to a plurality of mobile radio units.
3. A system as claimed in claim 1 or 2 arranged to make said later transmission automatically when a suitable communication path is available.
4. A system as claimed in claim 1, 2 or 3 comprising means for storing the contents of said call at its point of origin.
5. A system as claimed in claim 4, wherein said storage means is arranged also to act as a buffer to store part or all of the contents of a call during any delay between acceptance of a call request and the ability actually to transmit the call.
6. A system as claimed in any one of the preceding claims comprising means to store the contents of said call at a point in the radio system intermediate the means for attempting a call and the one or more target mobile radio units for subsequent retransmission to a

target mobile radio unit for which it is determined that no suitable communication path was available.

5 7. A system as claimed in claim 6 wherein means to store the contents of said call are located at a plurality of intermediate points in the radio system.

10 8. A system as claimed in claim 7 comprising a plurality of base stations having means to store the contents of said call.

15 9. A system as claimed in claim 6, 7 or 8 comprising means arranged to forward automatically stored call contents from a storage means at the point of origin of the call to said intermediate storage means when a suitable communication channel becomes available.

20 10. A system as claimed in any one of the preceding claims wherein said mobile units comprise means for storing a reply to a call for subsequent transmission to the point of origin of the call when a suitable communication path is available.

25 11. A mobile radio unit comprising storage means for storing the contents of a call when a suitable communication path to another part of a radio communications network is not available and means for transmitting said call contents to said radio communications network when such a communication path becomes available.

30

35 12. A radio communications network comprising a plurality mobile radio units and a plurality of base stations, each base station comprising means to store the contents of a call for subsequent retransmission to at least one mobile radio unit.

13. A mobile radio system as claimed in any one of the preceding claims wherein the storage means is arranged to store the contents of the call immediately and automatically.

5

14. A mobile radio system as claimed in any one of the preceding claims comprising means to store the contents of a call for any target mobile radio unit that cannot be located.

10

15. A mobile radio system as claimed in any one of the preceding claims arranged to connect said call substantially immediately to any located target mobile radio units for which a suitable communication path is available.

15

16. A method of operating a mobile radio system comprising attempting a call to at least one target mobile radio unit, determining whether a communication path is available from the point of origin of said call to the or each target mobile radio unit that can be located, and if a suitable communication path is not available, then storing the contents of said call for later transmission to said target mobile radio unit.

20

25

17. A method as claimed in claim 16 comprising attempting said call to a plurality of mobile radio units.

30

18. A method as claimed in claim 16 or 17 comprising making said later transmission automatically when a suitable communication path is available.

35

19. A method as claimed in claim 16, 17 or 18 comprising storing said contents of said call at its point of origin.

20. A method as claimed in claim 19, comprising storing part or all of the contents of a call during any delay between acceptance of a call request and the ability actually to transmit the message.

5

21. A method as claimed in any one of claims 16 to 20 comprising storing the contents of said call at a point in the radio system intermediate the point of origin of the call and the one or more target mobile radio units when it is determined no suitable communication path is available to a located target mobile radio unit and subsequently transmitting the call contents to a target mobile radio unit for which it was determined that no suitable communication path was available.

15

22. A method as claimed in claim 21 wherein said mobile radio system comprises a plurality of base stations, the method comprising storing the contents of the call at one or more of said base stations and subsequently transmitting the call contents to one or more mobile radio units.

20

23. A method as claimed in claim 21 or 22 comprising forwarding said stored call contents from the point of origin to said intermediate point when a suitable communication path becomes available.

25

24. A method as claimed in any one of claims 16 to 23 comprising storing a reply to said call at one or more of said target mobile radio units when a suitable communication path is not available and subsequently transmitting said reply to the point of origin of said call.

30

25. A method as claimed in any one of claims 16 to 24 comprising storing the contents of the call immediately and automatically.

35

26. A method as claimed in any one of claims 16 to 24 comprising storing the contents of a call for any target mobile radio unit that cannot be located.
- 5 27. A method as claimed in any one of claims 16 to 24 comprising connecting said call substantially immediately to any located target mobile radio units for which a suitable communication path is available.
- 10 28. Computer software specifically adapted to carry out the method of any of claims 16 to 27 when installed on data processing means.
- 15 29. A computer software carrier comprising software as claimed in claim 28 which when used to control one or more digital computers within a mobile radio system causes said system to carry out said method.
- 20 30. Computer software specifically adapted to carry out the steps of the method claimed in any of claims 16 to 27 except for the step of generating the message.
- 25 31. A mobile radio unit comprising means for storing sound and means for subsequently replaying said stored sound.
32. A mobile radio system substantially as hereinbefore described with reference to the accompanying drawing.
- 30 33. A mobile radio unit substantially as hereinbefore described with reference to the accompanying drawing.
- 35 34. A radio communications network substantially as hereinbefore described with reference to the accompanying drawing.
35. A method of operating a mobile radio system

substantially as hereinbefore described with reference
to the accompanying drawing.

- 5 36. Computer software substantially as hereinbefore
described with reference to the accompanying drawing.